Advantages

of

HYDRAULIC-PRESS BRICK COMPANY

MANUFACTURERS OF

Lightweight Hydraulic Haydite aggregate

SAINT LOUIS, MO. SOUTH PARK, OHIO

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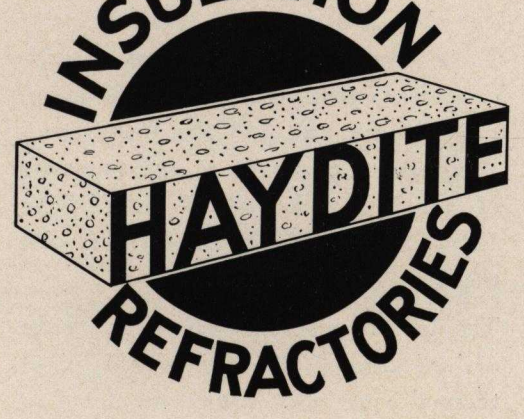

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Foreword

Facts brought out by extensive research conducted over a period of years by recognized laboratories and the HYDRAULIC-PRESS BRICK COMPANY as well as results of actual installations of HAYDITE-INSULATION-REFRACTORIES furnish the basis for this booklet.

The tables presented herein have been derived through the use of recognized thermal equations. Values are stated in round figures which are sufficiently accurate for practical purposes.

Design • OF HAYDITE-INSULATION-REFRACTORIES

Refractories and Thermal Insulation Materials constitute one of the outstanding problems of today.

It is generally agreed among recognized authorities that the presence of a definite percentage of Alumina tends to improve Refractory qualities; also, that cellular structure is essential for higher values in Thermal Insulation.

A combination of these factors, coupled with structural strength, ability to withstand slag action and spalling, plus economy in installation and upkeep, would produce a Refractory material that could be advantageously used in many installations.

HAYDITE - INSULATION - REFRACTORIES HAVE
ALL OF THESE QUALIFICATIONS

Advantages • OF HAYDITE-INSULATION-REFRACTORIES

(a) High thermal insulation.

(b) High crushing strength.

(c) Slag resistant without affecting thermal insulation qualities.

(d) Economy
- Lower first cost
- Longer service
- Fuel saving.

(e) Convenience of emergency or routine repairs; materials available either in pre-moulded shapes or in bulk form for monolithic placement.

(f) Light weight, resulting in lower installation cost as well as saving in time.

(g) Both special and standard shapes available on short notice without pre-firing. Grooves, slots or cores provided for rivet head or structural shape clearance.

(h) Low spalling even under extreme abuse.

Materials • AND HOW MANUFACTURED

The principal materials in HAYDITE-INSULATION-REFRACTORIES are HAYDITE lightweight aggregate, Vermiculite, Lumnite or Portland cement, and water.

HYDRAULIC LIGHTWEIGHT HAYDITE aggregate is an inert, expanded product made by burning clay or shale in a rotary kiln. The clinker thus formed is crushed and screened to produce a uniform, properly graded lightweight aggregate which, combined with Lumnite cement and water in definite proportions, forms an hydraulic bond.

The resultant product has high resistance to crushing loads which actually increases after the transition from hydraulic to ceramic bond which is accomplished upon subjection to maintained temperatures ranging from 1500° to 2000° F.

A special Lightweight Refractory Haydite aggregate "BX-4.00" is prepared for HAYDITE-INSULATION-REFRACTORIES.

Increased thermal insulation and lower unit weight may be attained with only a slight reduction in strength by substituting Vermiculite (an expanded mica produced under various trade names) for a part of the HAYDITE lightweight aggregate.

Either HAYDITE-LUMNITE-REFRACTORIES or HAYDITE-VERMICULITE-INSULATION products are designed to withstand maintained temperatures up to 2000° F.

When lower temperature ranges prevail and not in excess of 1200° F., economy in first cost may be had by substituting Portland for Lumnite cement.

Haydite lightweight aggregate contains practically no combustible material, and is so free of silt, sulphur and other impurities which are injurious to metals, that pipes, conduits, etc., may be embedded in Haydite concrete without danger of corrosion.

CHEMICAL ANALYSIS OF HAYDITE AGGREGATE

Loss on Ignition	0.50
Silica (SiO_2)	62.10
Alumina (Al_2O_3)	22.94
Iron Oxide (Fe_2O_3)	8.36
Lime (CaO)	0.36
Magnesia (MgO)	1.85
Sulphur (SO_2)	0.25
Alkalies ($As\ Na_2O$)	3.64
	100.00

The following tables are characteristic of HAYDITE-INSULATION-REFRACTORIES. "K" represents the coefficient of thermal conductivity expressed as B. t. u./hr./sq. ft./deg. Fahr./in. thickness, and "r" (1 etc.) is the thermal resistance of any individual refractory, and "R" (o or h) the thermal resistance of all refractories indicated.

Crushing strengths for "Brick" are stated on basis of standard fire brick size and shape, i.e., 9″x4½″x2½″, and corrections on compression strengths have been made in accordance with A. S. T. M. Standards and for cylinder specimens where H÷D=2, i. e., 2x4, 3x6, or 6x12.

In designing refractory brick walls to meet specific load conditions it must be borne in mind that rubbed, dipped or poured joints usually do not develop the full strength of the brick, particularly under temperature exposure.

The use of mortar made of one part cement (Lumnite or Portland, depending upon working temperatures), one-fifth part pulverized fire clay and two and one-half parts "AA-2.20" fine refractory HAYDITE in conjunction with HAYDITE-INSULATION-REFRACTORIES assures high strength and satisfactory thermal resistance in the refractory wall.

THE MIXING PROPORTIONS INDICATED IN ALL TABLES OF THIS BOOK ARE MADE BY DAMP, LOOSE VOLUME OF AGGREGATE, CALCULATING 1 SACK OF CEMENT AS 1 CUBIC FOOT

TABLE I

HAYDITE-VERMICULITE-INSULATION

MIX BY VOLUME—1 PART LUMNITE CEMENT
2 PARTS HAYDITE "BX-4.00"
3 PARTS VERMICULITE
UNIT WEIGHT 68.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½″	9″	13½″		For Brick	For Cylinders
75° F.	1.85	3.70	5.55	2.42	1,000	500
400° F.	1.80	3.60	5.40	2.50	750	375
800° F.	1.70	3.40	5.10	2.60	600	300
1200° F.	1.65	3.30	4.95	2.70	500	250
1600° F.	1.60	3.20	4.80	2.80	600	300
2000° F.	1.55	3.10	4.65	2.90	1,200	600

TABLE II

HAYDITE-LUMNITE-REFRACTORIES

MIX BY VOLUME—1 PART LUMNITE CEMENT, 4 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 88.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.45	2.90	4.35	3.13	5,000	2,500
400° F.	1.40	2.80	4.20	3.24	4,000	2,000
800° F.	1.32	2.65	3.97	3.38	3,000	1,500
1200° F.	1.28	2.55	3.83	3.52	2,500	1,250
1600° F.	1.22	2.45	3.67	3.66	3,000	1,500
2000° F.	1.18	2.35	3.53	3.80	4,000	2,000

MIX BY VOLUME—1 PART LUMNITE CEMENT, 5 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 82.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.60	3.20	4.80	2.82	4,000	2,000
400° F.	1.52	3.05	4.57	2.93	3,500	1,750
800° F.	1.46	2.93	4.39	3.06	3,000	1,500
1200° F.	1.40	2.80	4.20	3.20	2,000	1,000
1600° F.	1.35	2.70	4.05	3.33	3,000	1,500
2000° F.	1.30	2.60	3.90	3.46	4,000	2,000

MIX BY VOLUME—1 PART LUMNITE CEMENT, 6 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 79.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.78	3.56	5.34	2.52	3,000	1,500
400° F.	1.70	3.40	5.10	2.62	2,600	1,300
800° F.	1.63	3.26	4.89	2.75	2,000	1,000
1200° F.	1.55	3.10	4.65	2.87	1,500	750
1600° F.	1.50	3.00	4.50	3.00	2,000	1,000
2000° F.	1.44	2.88	4.32	3.12	3,200	1,600

MIX BY VOLUME—1 PART LUMNITE CEMENT, 8 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 74.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	2.22	4.45	6.67	2.27	2,000	1,000
400° F.	2.12	4.25	6.37	2.36	1,500	750
800° F.	2.02	4.05	6.07	2.47	1,200	600
1200° F.	1.92	3.85	5.77	2.57	1,000	500
1600° F.	1.85	3.70	5.55	2.68	1,200	600
2000° F.	1.77	3.54	5.31	2.79	2,400	1,200

TABLE III

HAYDITE-SEMI-REFRACTORIES

MIX BY VOLUME—1 PART PORTLAND CEMENT, 4 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 88.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.45	2.90	4.35	3.13	5,000	2,500
400° F.	1.40	2.80	4.20	3.24	4,000	2,000
800° F.	1.32	2.65	3.97	3.38	3,000	1,500
1200° F.	1.28	2.55	3.83	3.52	2,500	1,250

MIX BY VOLUME—1 PART PORTLAND CEMENT, 5 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 82.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.60	3.20	4.80	2.82	4,000	2,000
400° F.	1.52	3.05	4.57	2.93	3,500	1,750
800° F.	1.46	2.93	4.39	3.06	3,000	1,500
1200° F.	1.40	2.80	4.20	3.20	2,000	1,000

MIX BY VOLUME—1 PART PORTLAND CEMENT, 6 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 79.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	1.78	3.56	5.34	2.52	3,000	1,500
400° F.	1.70	3.40	5.10	2.62	2,600	1,300
800° F.	1.63	3.26	4.89	2.75	2,000	1,000
1200° F.	1.55	3.10	4.65	2.87	1,500	750

MIX BY VOLUME—1 PART PORTLAND CEMENT, 8 PARTS HAYDITE "BX-4.00"
UNIT WEIGHT, 74.0 LBS. CU. FT.

Maintained Inside Temperature	"r" Value for Wall Thickness Shown			Factor "K"	Crushing Strength lbs./sq. in.	
	4½"	9"	13½"		For Brick	For Cylinders
75° F.	2.22	4.45	6.67	2.27	2,000	1,000
400° F.	2.12	4.25	6.37	2.36	1,500	750
800° F.	2.02	4.05	6.07	2.47	1,200	600
1200° F.	1.92	3.85	5.77	2.57	1,000	500

COEFFICIENT OF EXPANSION AND HEAT CONDUCTIVITY of HAYDITE INSULATING AND REFRACTORY CONCRETE

The coefficient of expansion or contraction for HAYDITE-Insulation-Refractories ranges between .0000024 and .0000055 depending upon mixing proportions and working temperatures.

HAYDITE-LUMNITE INSULATING REFRACTORY CONCRETE

Temperature range in degrees Fahrenheit	MIX	Coefficient of expansion in inches per deg. Fahrenheit per in. in length
100° to 400°	1 part Lumnite cement 4 parts HAYDITE	0.0000024
400° to 700°		0.0000036
700° to 1400°		0.0000041

HEAT CONDUCTIVITY ("K" FACTOR)
Haydite-Lumnite Insulating Refractory Concrete

	TEMPERATURE IN DEGREES FAHRENHEIT					
Hot and Cold Side	547-253	845-355	1154-446	1457-543	1720-680	1905-894
Mean Temperature	400	600	800	1000	1200	1400
"K" Factor	3.15	3.25	3.40	3.47	3.55	3.57

HAYDITE-VERMICULITE-LUMNITE INSULATING REFRACTORY CONCRETE

Temperature range in degrees Fahrenheit	MIX	Coefficient of expansion in inches per deg. Fahrenheit per in. in length
100° to 400°	1 part Lumnite cement	0.00000302
400° to 700°	2 parts HAYDITE	0.00000343
700° to 1400°	3 parts Vermiculite	0.00000467

HEAT CONDUCTIVITY ("K" FACTOR)
Haydite-Vermiculite-Lumnite Insulating Refractory Concrete

	TEMPERATURE IN DEGREES FAHRENHEIT			
Hot and Cold Side	509-81	1004-90	1390-122	1705-325
Mean Temperature	295	547	756	1015
"K" Factor	2.50	2.62	2.75	2.95

The above HAYDITE-Lumnite Insulating and HAYDITE-Vermiculite-Lumnite Insulating Fire-resisting Concrete have comparatively high cold-set strength, exceedingly low shrinkage or expansion, and a low heat conductivity or "K" factor, with high refractoriness for temperatures up to 2000 degrees Fahrenheit.

After placing, it is hydraulic concrete, but upon exposure to operating temperatures, the hydraulic bond is converted to a ceramic bond with consequent high resistance to heat and an increased strength approaching its cold strength. It has a very low spalling action.

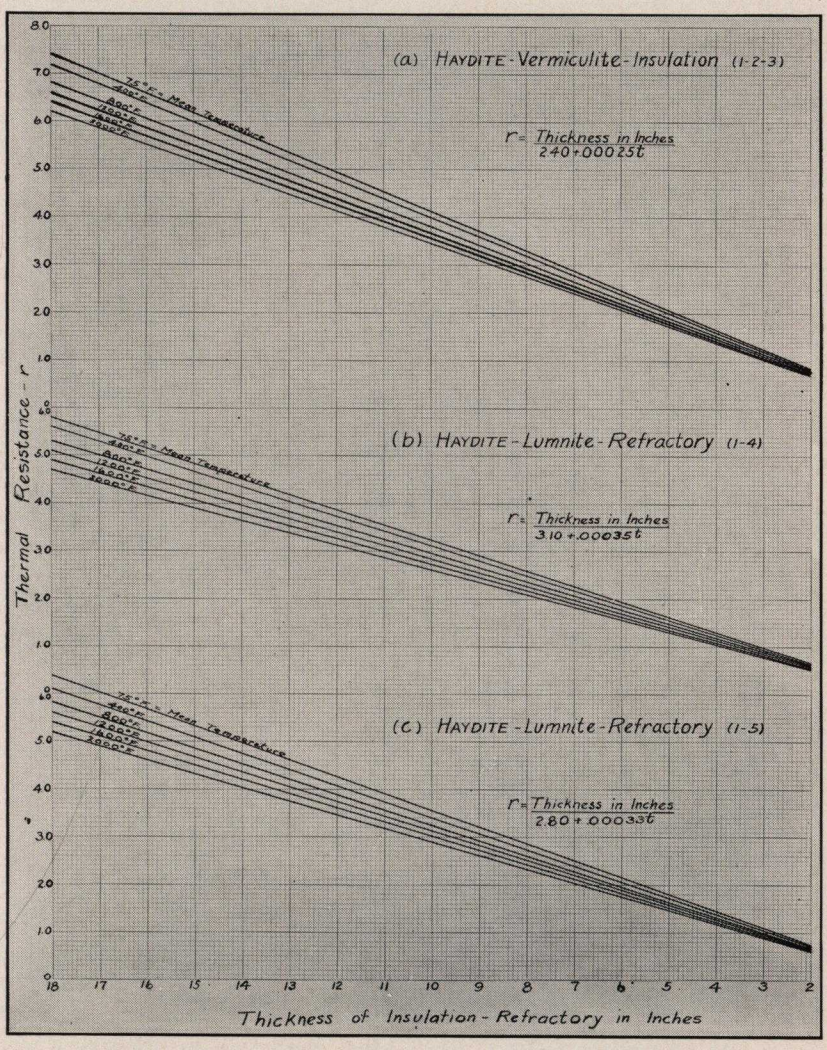


Fig. 1—Thermal resistance of Haydite-Insulation-Refractories.

(a) Haydite-Vermiculite-Insulation (1-2-3).

(b) Haydite-Lumnite-Refractory (1-4).

(c) Haydite-Lumnite-Refractory (1-5).

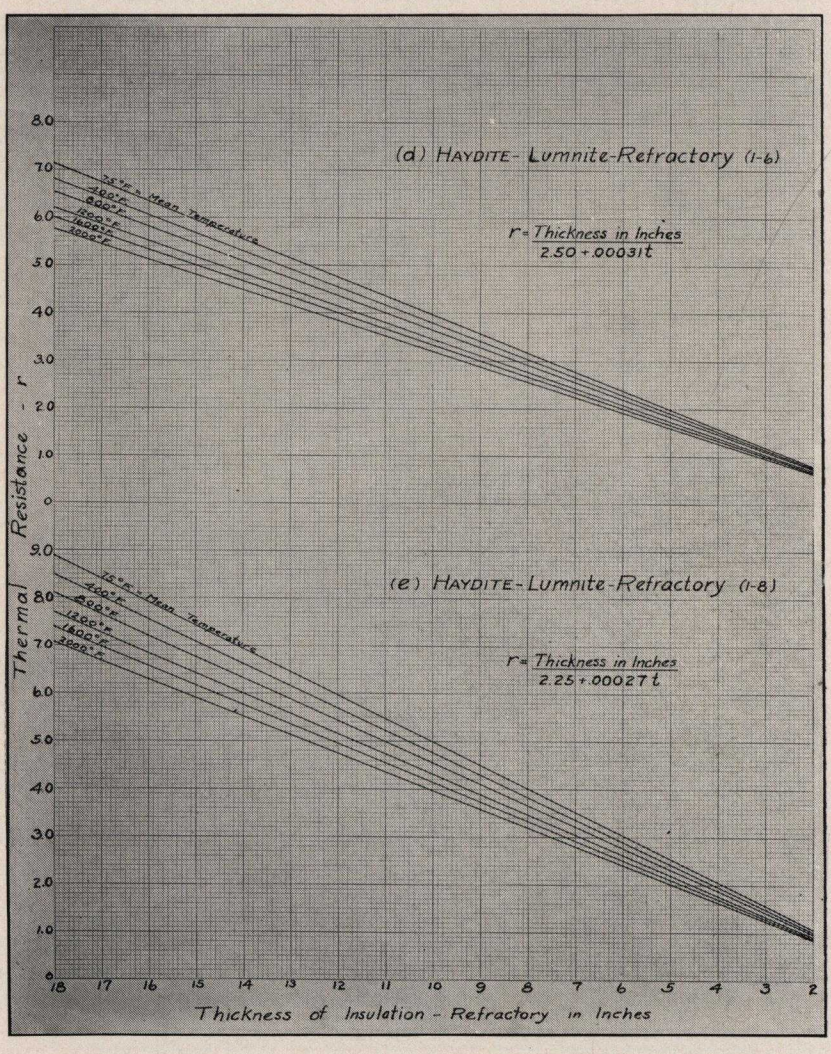


Fig. 2—Thermal resistance of Haydite-Insulation-Refractories.

(d) Haydite-Lumnite-Refractory (1-6).

(e) Haydite-Lumnite-Refractory (1-8).

Use the Haydite-Lumnite-Refractory thermal resistance Fig. 1 (b) (c) and Fig. 2 (d) (e) for Haydite-Semi-Refractories made with Portland cement but for temperatures up to 1200° F. only.

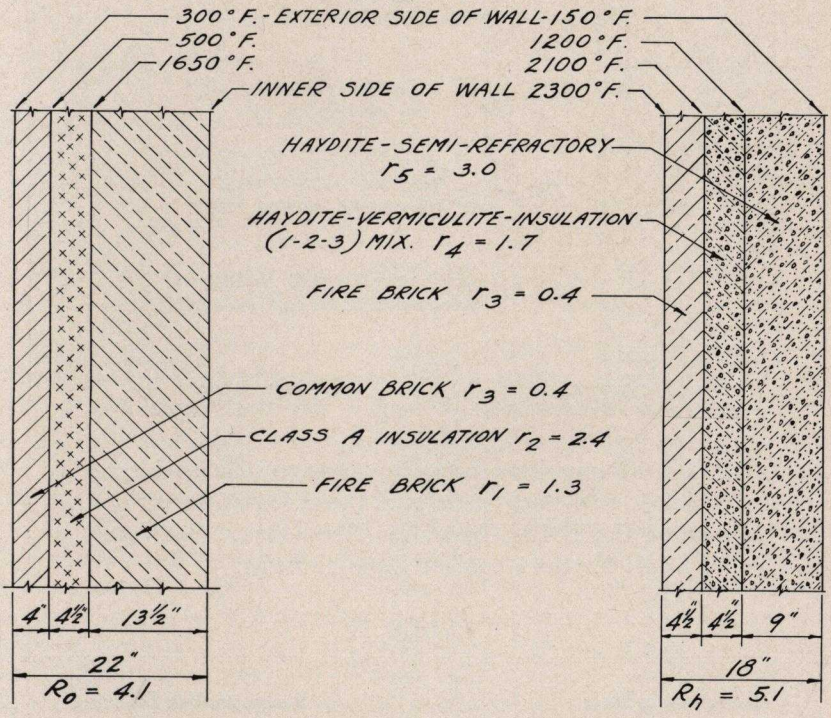


Fig. 3—Note improved thermal efficiency which means fuel saving in this wall comparison featuring HAYDITE-Vermiculite-Insulation and HAYDITE-Semi-Refractories.

Where HAYDITE-Insulation-Refractories are exposed to direct heat the application of one or two brush coats of a Kaolin or Chrome base high temperature cement is recommended; such as Brixaver, Brixene or their equal. Mix to slurry consistency using 15% (by volume) Sodium Silicate (water glass) in the mixing water.

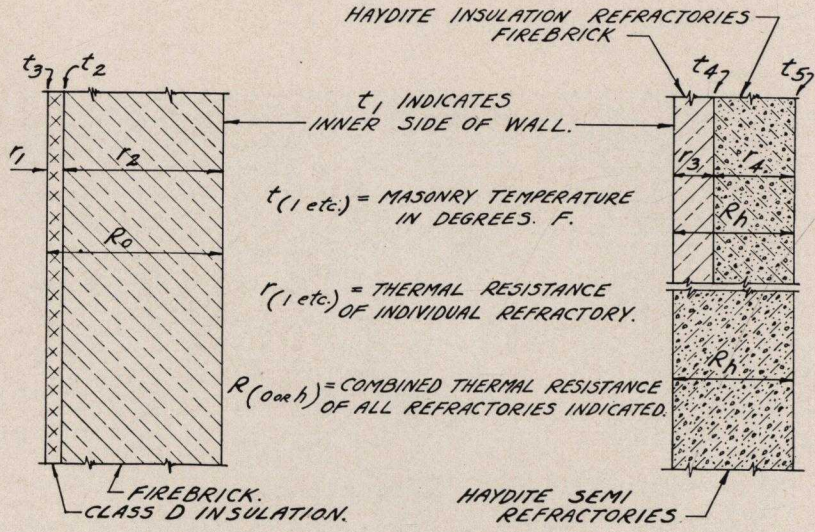


Fig. 4—Comparison between thermal efficiencies of ordinary refractory walls and those featuring various kinds of HAYDITE-Insulation-Refractories. See Table IV below for the complete characteristics:

TABLE IV

Characteristic Table for Ordinary Design of Wall						Design of Wall Featuring Haydite-Insulation-Refractories					
		REFRACTORY					REFRACTORY				
t 3	R 0	Thickness	Kind	"r" 1 or 2	t 2	t 1	Thickness	Kind	"r" 3 or 4	t 4	R h	t 5
300° F.	3.85	18″ 1¾″	Firebrick Plaster	2.00 1.85	1100° F.	2000° F.	4½″ 9″ Haydite-Lumnite (1-8)	Firebrick	0.48 3.37	1800° F.	3.85	300° F
300° F.	3.60	18″ 1½″	Firebrick Plaster	2.10 1.50	800° F.	1600° F.	4½″ 9″ Haydite-Lumnite (1-8)	Firebrick	0.50 3.75	1450° F.	4.25	265 F.
300° F.	3.65	13½″ 1½″	Firebrick Plaster	1.95 1.70	700°	1200°	9″ Haydite-Semi (1-8)				4.10	200° F.
300° F.	3.35	13½″ 1″	Firebrick Plaster	2.16 1.19	500° F.	800° F.	9″ Haydite-Semi (1-8)				4.21	150° F.

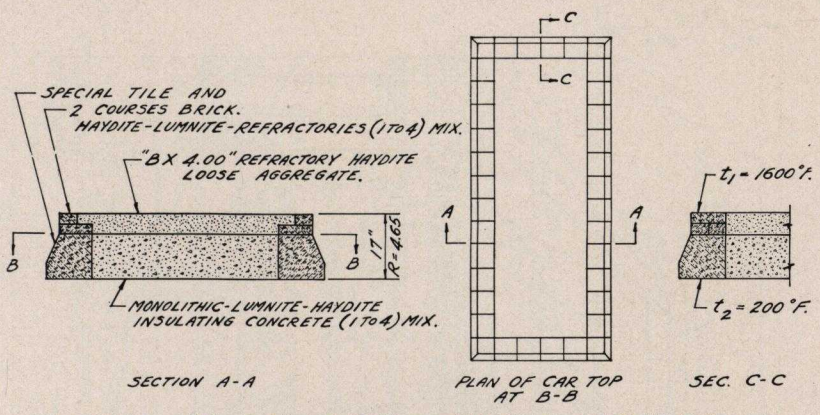


Fig. 5—Adaptation of "BX-4.00" Refractory HAYDITE in various forms for Steel Sheet Annealing Buggies.

Refractory and insulating concrete placed monolithically has the same strength and thermal insulation characteristics as in precast shapes for any given mix provided proper care is exercised in proportioning, mixing, placing and curing.

Use Lumnite cement in the same mixes as shown below for temperatures over 1200° F. Lumnite concrete usually sets in about 6 hours; test with moistened finger —if not soiled by test start sprinkling the concrete with water, keeping it damp until it is 24 hours old. "BX-4.00" refractory HAYDITE aggregate weighs 1,500 to 1,600 pounds per cubic yard. Mixes to be made by loose volume, calculating 1 sack of cement as 1 cubic foot, allowing 1.0 to 1.1 cubic yards of aggregate per cubic yard of concrete. Recommend pre-wetting aggregate in advance of mixing. Moisture in excess of 7 per cent will be effective as mixing water. The water cement ratio indicated below gives most efficient insulation and best yield. Vibration with not less than 3600 impulses per minute will facilitate placing the concrete, portable vibrators usually proving quite efficient.

TABLE V.*

DATA ON HAYDITE INSULATING FILLS FOR USE ON VARIOUS TYPES OF FURNACES AND STRUCTURAL CONCRETE FOUNDATIONS EXPOSED TO HEAT

Mix	Sacks Cement Cu. Yd. Concrete in Place	Gallons Water Per Sack Cement	Compression Strength Pounds Per Square Inch		Dry Weight Per Cubic Foot of Concrete— Pounds	"K" at 600° F.
			75° F.	1200° F.		
1-13.5	2.2	12.5	400	200	71	1.70
1-12	2.5	10.0	600	300	72	1.87
1-10	3.0	8.5	800	400	73	2.14
1-8	3.8	7.0	1000	500	74	2.41
1-6	5.0	5.5	1500	750	79	2.68
1-5	6.0	5.0	2000	1000	82	3.00
1-4	7.5	4.5	2500	1250	88	3.31

* Compression strengths in the foregoing table have been stated on basis of cylinders with H÷D=2 in accordance with A.S.T.M. Standards on Compression strengths.

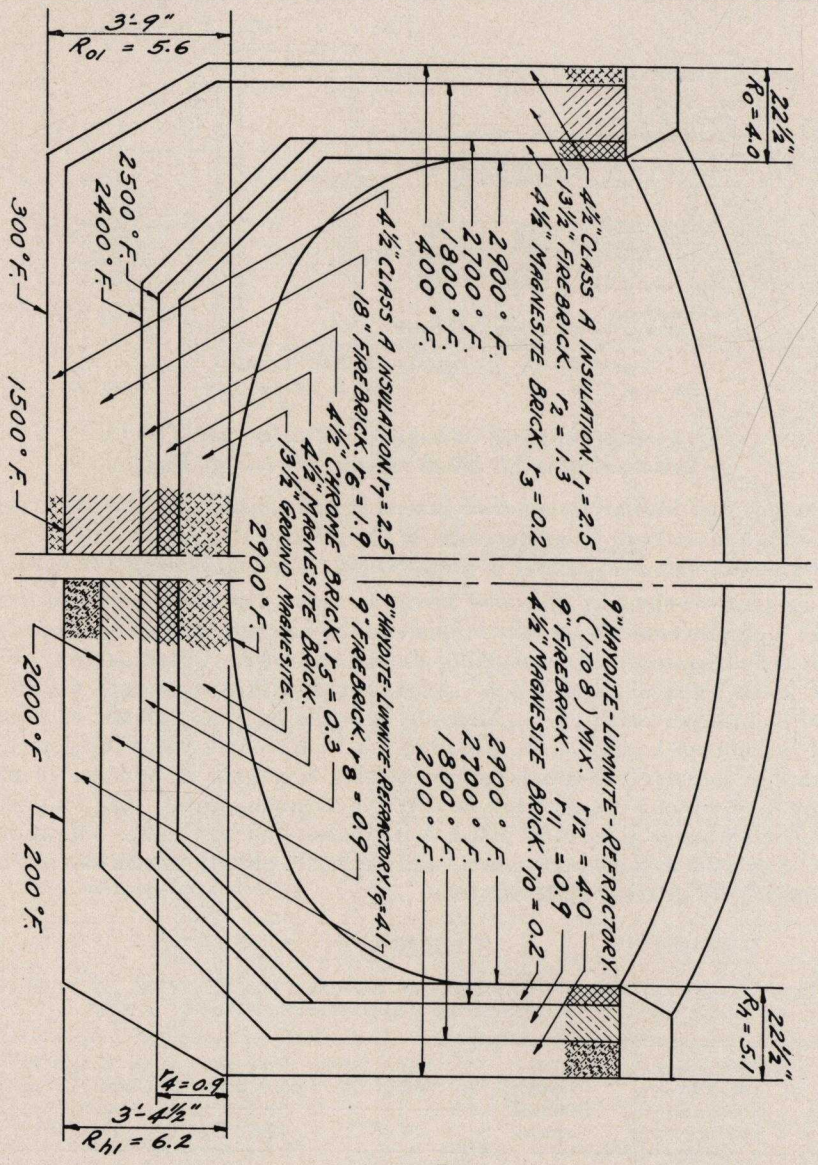


Fig. 6—Comparison of thermal efficiencies in 2 types of Open Hearth Furnace construction.

(a) Half section at the left covers Furnace Bottom and wall using ordinary construction with Class A Insulation.

(b) Half section at the right shows improved thermal efficiency with HAYDITE - Lumnite - Refractory.

Heat emission comparisons when developed for any given condition usually reflect a substantial fuel saving which can be realized thru the use of HAYDITE-Insulation-Refractories.

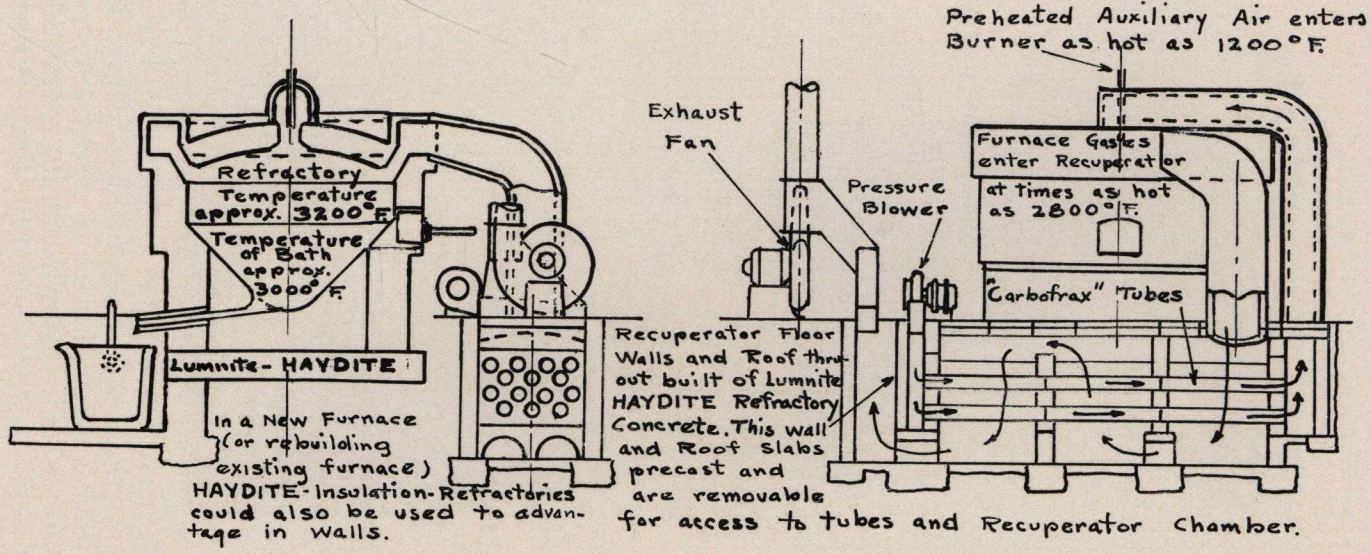
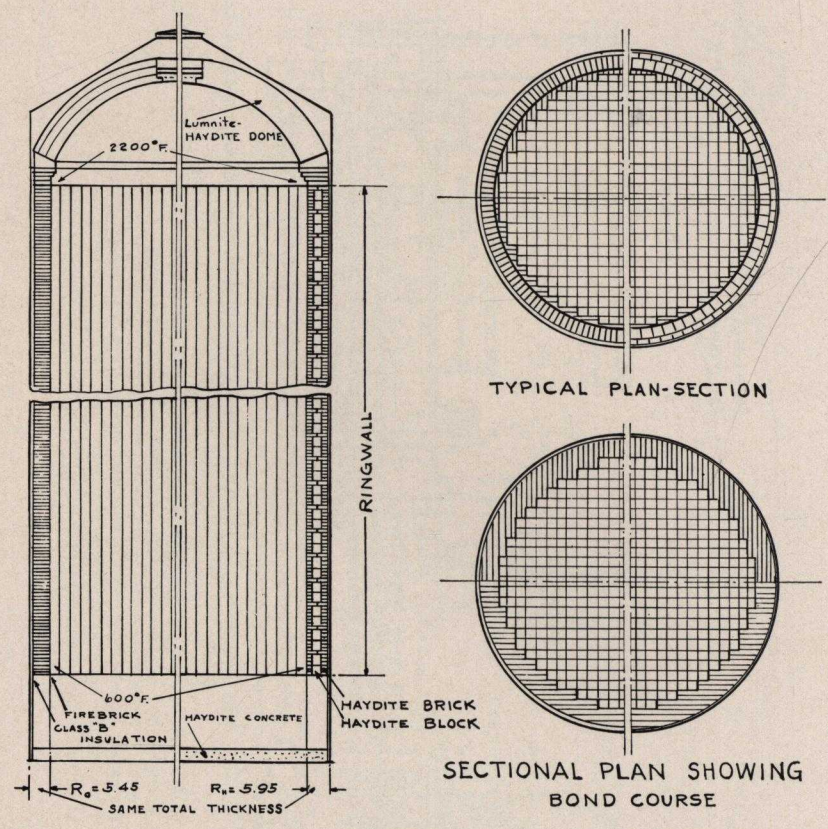


Fig. 7—Melting Furnace with Recuperator featuring various uses of HAYDITE-Insulation-Refractories. Thermal results are based upon existing installation in a large steel foundry.



HAYDITE brick and block for lower third of Ringwall height and brick in outer course only of entire Ringwall height may be made with Portland cement. The HAYDITE brick and block for the balance of the Ringwall to be made with Lumnite cement.

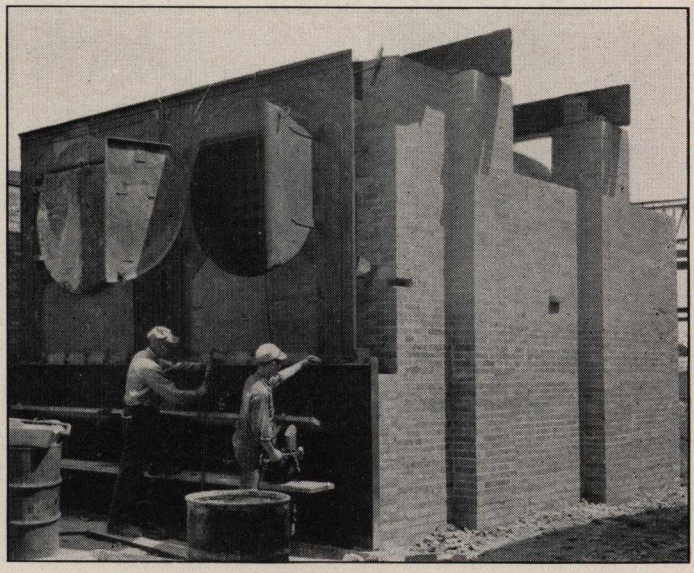
HAYDITE block approximately 9″ in cube to be bonded every 7 courses of brick.

A thin layer of HAYDITE-Vermiculite fill or Plastic Insulation may be placed between the steel shell and the outer course of Ringwall brick.

Fig. 8—2 types of construction for Blast Furnace Stove Ringwall and Dome.

(a) Half sections at the left of center lines cover use of Refractories ordinarily used with Class B Insulation.

(b) Half sections at the right of center lines feature HAYDITE and HAYDITE-Insulation-Refractories in various forms with improved thermal efficiency and marked resultant economies. Usually a saving equivalent to the cost in place of the Class B Insulation can be effected.



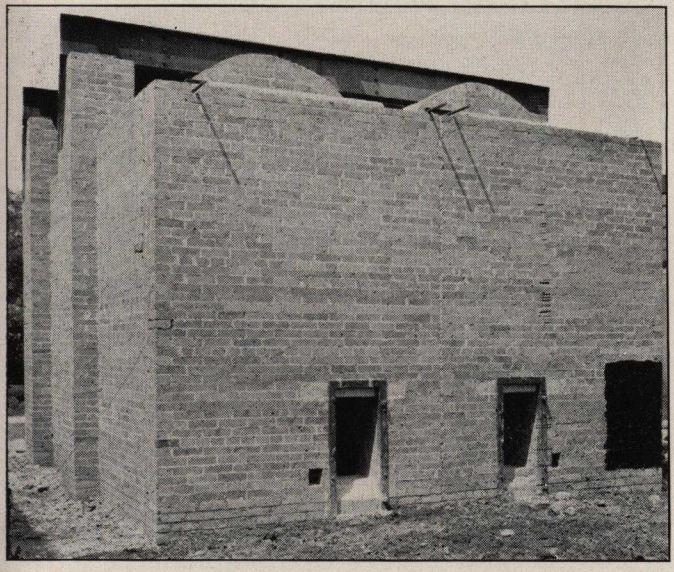
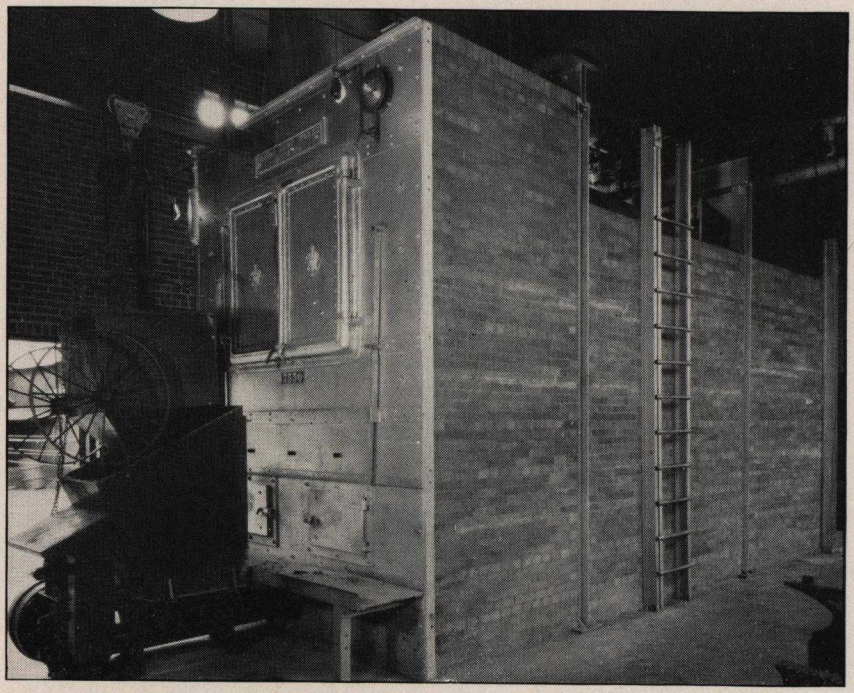
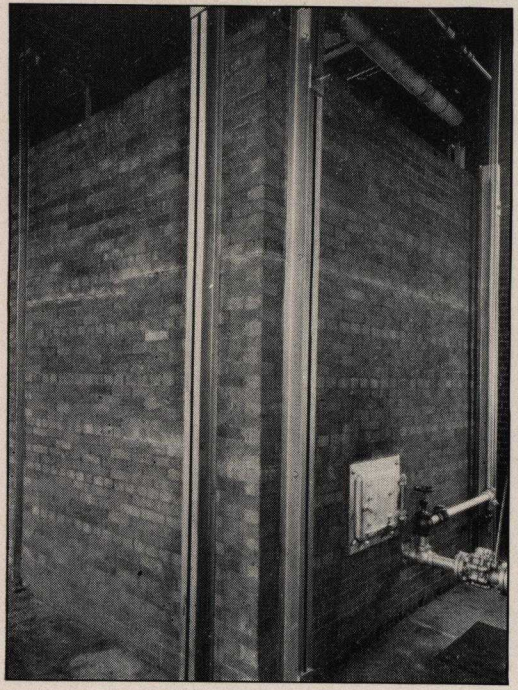


Fig. 9—2 - 100 H.P. H.R.T. Boilers. Exterior walls of setting built of HAYDITE-Semi-Refractory with fire brick lining in fire box.

HAYDITE-Refractory-Insulation can be used with increased thermal efficiency and other resultant economies, in practically all types of industrial furnaces.





For such installations Haydite offers the advantages of thermal insulation, high crushing strength, light weight, and low spalling action, all combining to give economy and long service. Haydite brick meet the requirements for Header bonding in high walls without loss of thermal insulation.

Fig. 10—1-150 H.P. H.R.T. Boiler. Exterior walls of setting built of HAYDITE-Semi-Refractory with fire brick lining in fire box.

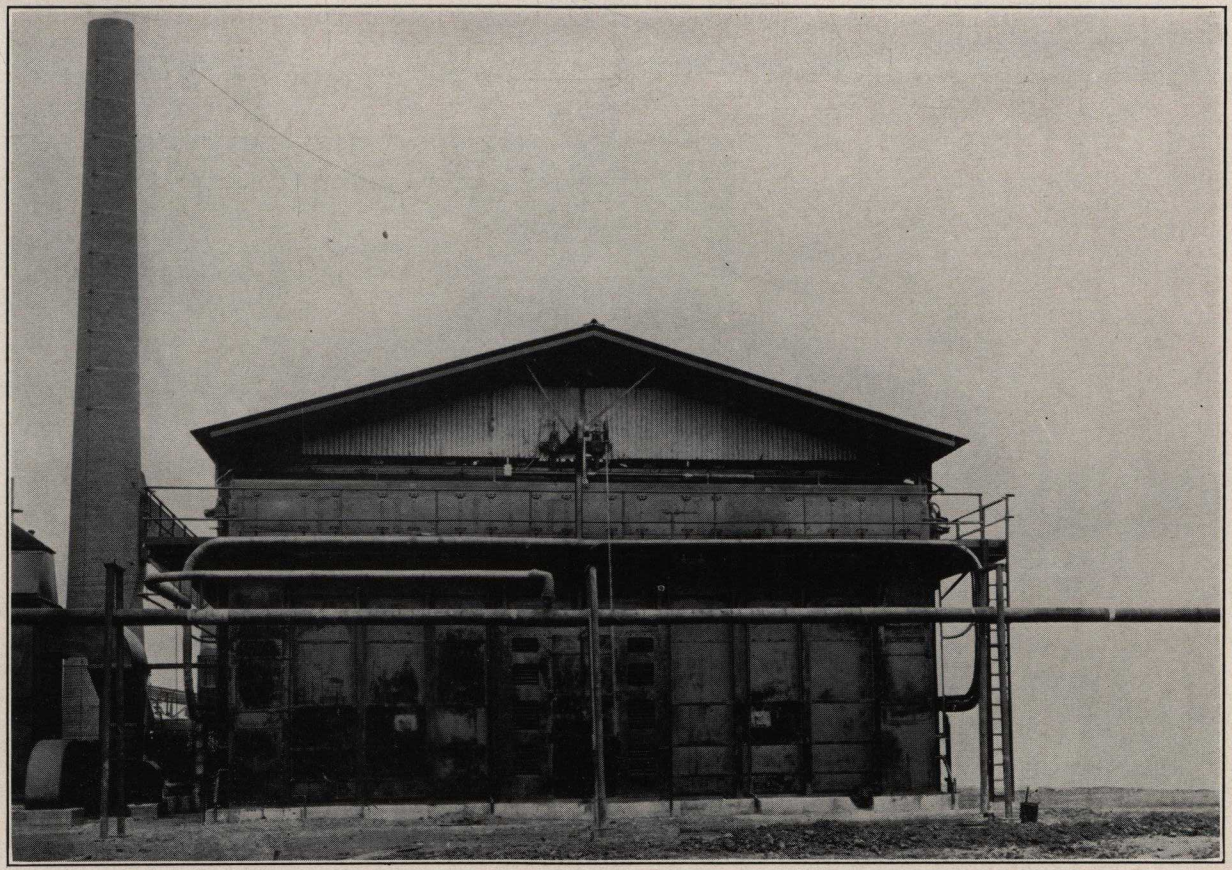


Fig. 11—The above illustration shows a typical Oil Still or Heater in which HAYDITE-Insulating-Refractory Concrete is used for:

(a) Lining cast iron tube supporting plates exposed to combustion chamber temperatures.

(b) Supporting slabs for the fire brick floors.

(c) Lining flues.

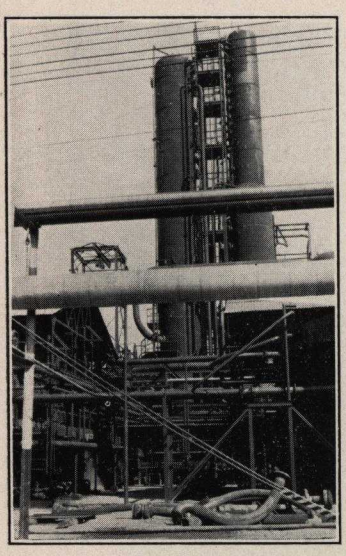


Fig. 12—Cracking Tower in a large Oil Refinery. Steel plates protected against corrosive action at temperatures of 700 to 800 degrees Fahrenheit with 2 inches of Lumnite-HAYDITE-Gunite; Reinforcing consists of cyclone fence mesh welded to inner face of steel plates on 6 inch centers; "AX-3.25" Refractory HAYDITE Aggregate is ideal grading for cement gun work of this character.

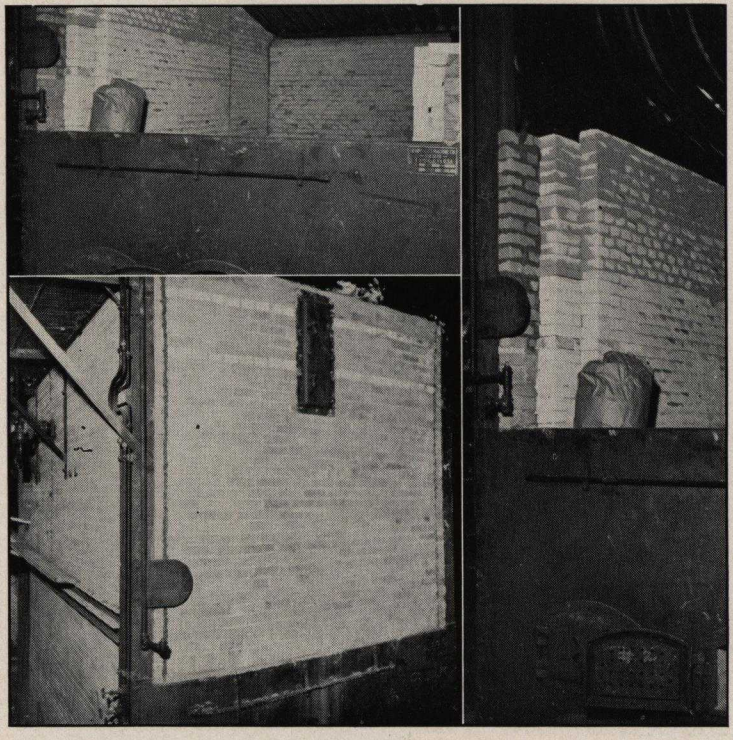


Fig. 13—1-295 H. P. Water Tube Boiler. Exterior walls of setting built of HAYDITE-Semi-Refractory laid up in HAYDITE Refractory Mortar with fire brick lining in fire box. Lumnite-HAYDITE Refractory Concrete Baffles cast in place.